



# Seminar and Roundtable on Coalbed Methane Development and Potential



## CHINA

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### Current CBM Activities

- CBM Development Project in Panzhuang Mine
- Asian Development Bank (ADB) Sponsored CBM Project
- APEC Coal Mine Gas Project
- CBM Exploration and Development in the Yangquan Coal Area
- Texaco Huaibei CBM Development Project
- Xinji Coalbed Methane Project
- Arco Project
- Philips Project
- UN-GEF Development of CBM Resources
- UN Deep CBM Exploration Project

### Key Factors in Energy Economy

- China is the world's largest producer of coal, producing 1.25 billion tons in 1994.
- China is also the world's largest consumer of coal, which supplies about 75% of the country's total energy needs.

### Potential Role of CBM in Energy Economy

- More than a three-fold increase in CBM production in mine-drained CBM utilization is possible and would result in an overall volume of  $1 - 2 \times 10^9 \text{ m}^3$ . This compares with a 1990 natural gas production level of  $15 \times 10^6 \text{ m}^3$ .
- The main potential use of this mine gas is within the Coal Mining Administration (CMA) and is less likely to attract international commercial investment.
- The total CBM resource in China is  $30-35 \times 10^{12} \text{ m}^3$  to depths of 2,000m.
- Total CBM emitted is estimated at  $\sim 5 \times 10^9 \text{ m}^3$  by U.S. EPA, and  $19 \times 10^9 \text{ m}^3$  by the UNDP, and  $7.7 \times 10^9 \text{ m}^3$  by the Ministry of Coal Industry (MOCI).
- In 1996, the total CBM recovered was  $618.6 \times 10^6 \text{ m}^3$ , which was



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roughly 8% of total emissions.

### CBM Potential

The development of CBM from surface boreholes has great potential. The China United CBM Co. Ltd. has set targets for CBM production in China from surface boreholes of  $1 \times 10^9$  m<sup>3</sup>/year by the year 2000 and  $10 \times 10^9$  m<sup>3</sup>/year by 2010.

### Existing Policies Affecting CBM Development

- China Agenda 21 – White Paper on China's Population, Environment and Development for the 21st Century: Is relevant to CBM development in that it: 1) promotes an increase in CBM development and utilization; 2) suggests providing incentives to support development of clean energy resources (including CBM); and 3) directs the Chinese energy industry to “develop and utilize coalbed methane resource[s], strengthen coalbed methane resource evaluation, and introduce underground or surface recovery and utilization technologies to control greenhouse gas emissions from coal mines to the atmosphere”
- The Mineral Resources Law (1986): Encourages additional foreign investment by providing a comprehensive legal framework for coal exploration and exploitation.
- Provisional Regulation and Rules for the Management of Exploration and Development of Coalbed Methane (1994): Promotes the “... rational development and utilization of coalbed methane resources, strengthening the management of exploration and development of coalbed methane resources and ensuring that the exploration, planning, design and mining operation of coal resources will not be affected by the exploration and development of the coalbed methane.”
- The Reform Agenda (1997) Restructure State Enterprises: Speeds up a program to convert state enterprises, which account for a third



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of industrial output, into corporations owned by stockholders.

Government ownership could even be reduced to minority stakes.

- Sell State Assets: Allow government bodies to sell off all but 1,000 of China's 305,000 state enterprises. Companies that can't be sold will go bankrupt.

### Overseeing or Permitting Government Agencies

- State Council
- China United Coalbed Methane Corporation Limited
- State Development Planning Commission
- Ministry of Land and Natural Resources (former Ministry of Geology and Mineral Resources)
- State Coal Industry Bureau (former Ministry of Coal Industry)
- China National Petroleum Corporation
- Ministry of Foreign Trade and Economic Cooperation

### Potential Barriers to CBM Development

- Lack of technology
- CBM mine safety is the principle business concern
- Lack of infrastructure
- Lack of awareness of environmental issues
- Lack of funds for investment in CBM

### Donors/ Companies/ Investors Active in CBM

World Bank, U.S. Environmental Protection Agency, Asian Development Bank, UNDP, UNEP, Texaco, ARCO, Phillips, Amoco, Enron, Sino-American Energy Co., Lowell Petroleum Co., BHP, AMT Drilling Co., State Development Planning Commission, Ministry of Science and Technology, State Development Bank, State Coal Industry Bureau, Ministry of Land and Natural Resources, China National Petroleum Corporation, China United Coalbed Methane Corporation Limited, Zhongyuan Oilfield, Huabei Oilfield, Northern China Bureau of



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Petroleum Geology, Jindan Energy Research and Development Co.,  
Yanquan Coalbed Methane Development Co., Huawell Petroleum,  
Central Coal Research Institute Xi-an Branch, Star Mining Corp.



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## CBM Development Project in Panzhuang Mine

### Contact Information

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### Status

Operational

### Location

Panzhuang Mine, Jincheng CMA

### Technical Summary

The project started in 1994 as a joint undertaking between Jincheng CMA and the American partner Sino-American Energy Co. Ltd. in equal partnership. So far, 7 surface wells have been drilled and all have undergone fracturing. Of the 7 wells, 4 are in stable production with single well peak production exceeding 10,000 m<sup>3</sup>/d. Water discharge for gas production for the latter 3 wells is underway with gas production ranges of 500-1800 m<sup>3</sup>/d. Gas produced is being used for power generation and a small 2X120 kW power plant is operational. Further 4X220 kW units have been ordered and will be put into operation shortly.

### Estimated Capital and O&M Costs

Cost of a production well is ~\$310,000 (1\$US to 8.3 yuan) including and O&M costs. The partners equally contributed investment for the



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project in Panzhuang Mine. The Shanxi provincial government provided an initial loan of US\$1,205,000.

## Sources of Revenue

CBM produced will be used for power generation for on-site use resulting in savings in electricity purchasing costs.

## Proponents/ Sponsors of the Project

- Jincheng CIVIA & Sino-American Energy Co. Ltd.
- Jin An'xin
- Shanxi-Jindan Energy Research & Development Co. Ltd.

## Lessons Learned

CBM development using surface wells has to be adapted according to site-specific conditions. American experience cannot be copied into China without being adapted. For example, initial production from the No. 2 well reached more than 10,000 m<sup>3</sup>/d but was not sustainable at this level. By using a high pumping rate, as was requested by the American partner, the well became clogged with sand and fine coal. In another case, the No. 3 well initially had a packer installed to block water coming from underneath the target seam. Stable gas production was recorded at more than 12,000 m<sup>3</sup>/d. When the packer was removed, the water level increased, dramatically stopping gas production. The water problem persisted for a considerable period of time. In later wells, pumping was maintained at an appropriate rate, and stable gas production of ~5,000 m<sup>3</sup>/d was achieved for more than a year.



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**Asian Development Bank (ADB) Sponsored CBM Project**

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**Status**

On-going

**Location**

Yangquan CMA, Yangquan City, Shanxi Province

**Technical Summary**

The project has three phases:

- Phase 1. Survey of CBM resources, development status, and policy and legal framework governing CBM development; project inventory and target area selection; and determination of a specific integrated CBM development and utilization project. The first phase of the project was conducted early in 1998 and completed in May 1998.
- Phase 2. Feasibility study for a CBM-fired power plant in Yangquan CMA, Shanxi Province. Initiation of the 2nd phase is set for October 1998 and will be completed in ~6 months.
- Phase 3. Detailed engineering design, construction, and commissioning of the power plant. Phase 1 was initiated in 1998 and completed in May of that year. Phase 2 is scheduled for October 1998 and will be completed in ~six months. Phase 3 will depend on the results of the feasibility study.



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## **Estimated Capital and O&M Costs**

ADB provided a US\$700,000 technical assistance fund for the 1st and 2nd phases of the project. ADB will provide a loan of approximately US\$50~100 million to complete the 3rd phase.

## **Sources of Revenue**

Power generated using CBM drained from underground mines in Yangquan will be used on-site for mine production. This will reduce electricity purchasing costs.

## **Proponents/ Sponsors of the Project**

Asian Development Bank  
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**APEC Coal Mine Gas Project**

**Contact Information**

Yang Shi'an  
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**Status**

On-going: The project is divided into three phases:

- Phase 1 (1996-97) - Site Study in China and selection of project site.
- Phase 2 (1996-97) - Preliminary engineering study.
- Phase 3 (1998) - Design in details, facility manufacturing, construction, and operation.

**Location**

Tiefa City, Liaoning Province

**Technical Summary**

Updated technology for a CBM recovery/utilization will be needed.

**Estimated Capital  
and O&M Costs**

APEC provided grant of US\$15 million.

**Sources of Revenue**

Gas sales to nearby cities.



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**Proponents/  
Sponsors of the  
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**CBM Exploration and Development in  
the Yangquan Coal Area**

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**Status**

Exploration

**Location**

Yangquan City, Shanxi Province

**Technical Summary**

The project will adopt surface vertical wells in advance of mining to recover CBM. Under the project, CBM will be directly sold to the end users in the nearby cities and towns.

**Estimated Capital  
and O&M Costs**

Project plans call for drilling 184 wells. The capacity of production is about  $2 \times 10^8 \text{ m}^3/\text{a}$ . The lifetime of the project is 20 years. The stable production period is 15 years. The capital cost of the project is about US\$120 million. The operation cost during the stable production period is about US\$5.7 million.

**Sources of Revenue**

The minimum investment in the exploration period will be US\$2.4 million. China United Coalbed Methane Co. Ltd. will invest US\$1.7



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million. Both China Coal Geological Bureau and Yangquan CMA will invest US\$360 thousand.

**Proponents/  
Sponsors of the  
Project**

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**Texaco Huaibei CBM Development Project**

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**Status**

Exploration

**Location**

Huabei, Anhui Province

**Technical Summary**

The project started in 1998. In the 1998-1999 exploration period, Texaco will drill several test wells and coal boreholes to obtain production data and then submit a feasibility report. If the project is feasible, Texaco will select an appropriate area to drill four or five production wells around an exploration well. If these wells are successful, development will follow. Finally, Texaco will drill 300 surface wells, and the total gas production is expected to reach 500 million m<sup>3</sup>. The produced gas will be supplied to household users, followed by power generators and chemical producers.

**Estimated Capital  
and O&M Costs**

The cost of a production well is ~2.6 million yuan including drilling, fracturing, and well completion and testing. The operating cost per well with a gas production of 5,000 m<sup>3</sup>/d is 88,000 yuan. The total investment will be US\$500 million for the project with



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300 surface wells and necessary surface facilities including pipelines and compressing stations, etc.

**Sources of Revenue**

Project revenues will come from gas sales to household users and industrial users as well as sales of electricity generated with coalbed methane.

**Proponents/  
Sponsors of the  
Project**

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**Xinji Coalbed Methane Project**

**Contact Information**

Huainan Coal & Electricity General Corporation

**Status**

Operational

**Location**

Huainan City, Anhui Province

**Technical Summary**

The project will adopt surface wells in advance of mining.

**Estimated Capital  
and O&M Costs**

The estimated capital cost of the project is about US\$6.7 million, of which the National Science and Technology R&D fund accounts for US\$2.5 million. Huainan Coal & Electricity General Corporation, the Coal Science Research Institute Xian's Branch, Huaibei Petroleum Geology Bureau, etc. will provide funds for the supporting project and development estimated at US\$4.2 million.

**Sources of Revenue**

The project is expected to produce  $6\sim7 \times 10^6 \text{ m}^3 \text{ CBM}$  each year. The price of CBM is about US\$0.12/ $\text{m}^3$ . The output can reach US\$720-840 thousand.  $2.4\sim2.8 \times 10^4 \text{ t}$  coal can be saved every year, therefore, US\$580~670 thousand can be saved every year.

**Proponents/  
Sponsors of the  
Project**

Huainan Coal & Electricity General Corporation



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**ARCO Project**

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**Status**

Feasibility

**Location**

Sanjiao, North Sanjiao and Shilou, Shanxi Province

**Technical Summary**

On 29th June 1998, Arco signed contracts with CUCBM for the exploration of CBM using surface boreholes from these three areas. The contract is based on a risk exploration and product sharing model. Development will proceed if appraisal efforts are successful, with startup possible by 2003.

**Estimated Capital  
and O&M Costs**

Gross development costs of the Phase 1 appraisal program are expected to total US\$52 million.





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**Proponents/  
Sponsors of the  
Project**

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**Phillips Project**

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**Status**

Feasibility

**Location**

Linxing, Shanxi Province

**Technical Summary**

On 29th June 1998, Phillips signed contracts with CUCBM for the exploration of CBM using surface boreholes from the area. The contract is based on a risk exploration and product sharing model.

**Proponents/  
Sponsors of the  
Project**

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## UN-GEF Development of CBM Resources

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### Status

Almost completed

### Technical Summary

In 1992, the UNDP began a five-year technical assistance project on CBM in China. Both the UNDP and the Chinese Party have contributed approximately US\$10 million to the project. Star Mining Corp. implements the study on behalf of the former Ministry of Coal Industry. One of the main achievements of the project is that it has drawn attention to and enhanced the status of CBM production with the Chinese Government.

The project has four sub-projects, which are located at Tiefu (Liaoning Province), Kailuan (Hebei Province), Van (Shaanxi Province), and Songzao (Sichuan Province). So far, the Sub-projects of Tiefu, Kailuan, and Van have been completed, while the Songzao sub-project is still in progress.

(1) Kailuan Sub-project. The sub-project was jointly implemented by Kailuan CMA and Gustavson Associates Inc. Three wells have been drilled from the surface into a coal seam prior to mining for the project. Good daily gas production has been achieved from one well



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(2000m<sup>3</sup>/d), but production has been low from the others, even though stimulation measures (fracturing) have been taken. Drilling was undertaken with a second-hand surface rig procured by the UNDP, and there have been some problems and delays caused by the requirement for imported spares. Gas produced from one of the surface wells has been injected into the town gas system nearby. The revenue of the project will come from gas sales to local users.

(2) Tiefa Sub-project. The sub-project was implemented by Tiefa CMA and REI Co. The purpose of the sub-project was to introduce gob well and long horizontal borehole drilling technologies to Chinese coal mines. Three gob wells were drilled from the surface to 40-50m above the working seam at depths of 500-600m. Additionally, three long in-mine horizontal boreholes were directionally drilled into the gob area using a downhole motor, the longest borehole extended 305m. Total gas production was 1.67 million m<sup>3</sup> from the in-mine boreholes and 3.08 million m<sup>3</sup> from the surface gob wells. Meanwhile, the methane drainage efficiency was increased by 57.2% over conventional methods (cross-measures borehole).

(3) Van Sub-project. The purpose of this sub-project was resource assessment. The sub-project was implemented by Central Coal Research Institute Van Branch. Data collection is completed for 17 mining areas and a database on national coalbed methane resources has been established. Seventeen coal seams have been completely tested and 10 more exploration wells have been drilled in 12 mining areas. Two major technology transfer training courses, each three weeks in duration, have been held in Xi'an, in 1996 and 1997, with instructions from the USA.



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(4) Songzao sub-project. The purpose of the sub-project was to drill long in-seam directional boreholes. REI Co. and Songzao CMA undertook the sub-project. Two boreholes were drilled in Shihao mine and Datong No. 1 mine. Both boreholes failed due to soft rock, gas outburst, and drill-rod bogging.

A new subcontractor, ATM Drilling Co., has begun drilling in the No. 8 seam. They have experienced problems with the contrasting hard and soft rock lithology, but managed to drill a 102 m horizontal borehole. The Songzao sub-project has also installed a set of six CBM monitoring systems which measure flow rate, pressure difference, temperature, and methane concentration.

## **Proponents/ Sponsors of the Project**

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## **Lessons Learned**

### **(1) Capital**

The investment in the UNDP project consisted of 10 million US dollars through GEF, 40 million yuan by Chinese government, and the rest raised by each enterprise that is involved in the project.

The late arrival of domestic support capital and the late delivery of foreign equipment postponed the start of the project for one year.

### **(2) Choice of Contractor**



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Contractors were chosen for the three development sub-projects by international tendering. Due to lack of related expertise and experience, few contractors can overcome technical problems in time when encountering difficult conditions during project implementation. For example, the project was delayed during the implementation of Songzao sub-project because the contractor had to be changed.

### (3) Technical Problems

Because all the technologies adopted by the UNDP project are new, Chinese technical personnel conduct operations mostly under the instruction of foreign experts. The main technical problems encountered during project implementation were as follows:

- Severe mud loss with surface well-drilling, frequent failure, and heavy maintenance with the second-hand surface drill;
- Sand removal, pump holding back, and mud loss during gob well drilling;
- Drilling rod bogging and rapid wear of drilling bit when drilling long in-mine horizontal boreholes, less experience with drilling long horizontal boreholes in soft rock, and high gas outburst coal seams.

### (4) Management of Coalbed Methane Resources

A dispute over management of coalbed methane resources occurred in the Kailuan sub-project. The focus of the dispute involved the geographic area where the coal mining license had been issued, and whether the registration and licensing procedure should be performed regarding coalbed methane exploration and development.



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## UN Deep CBM Exploration Project

### Contact Information

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### Status

Completed

### Location

Linxing, Shanxi Province

### Technical Summary

The UNDP sponsored Deep CBM Exploration Project was initiated in August 1993 and completed in December 1996. The project was carried out in 3 phases. The 1st phase was geological evaluation to select target areas. The 2nd phase involved gas production experiments in selected target areas using a small-scale surface well group. The 3rd phase evaluated overall development potential and the economics of development areas.

In the first phase, eight areas were selected for initial evaluation, and four were selected for further evaluation. In the second phase, 7 surface wells were drilled in the Liulin area for trial production and achieved a satisfactory outcome. Of the 7 production wells, 6 wells had stable production of more than 1000 m<sup>3</sup>/d, and one well had a peak production of 7050 m<sup>3</sup>/d. The well also had a long stable production of 400~6000 m<sup>3</sup>/d. Computer simulation of production from the 7 wells over a 20-year period indicated that over 47 million m<sup>3</sup> of gas could be produced.



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A set of technical reports was prepared as an outcome of the project.

These include:

- (a) CBM geological evaluation and target area selection,
- (b) Production prediction and economic evaluation from the Liulin experimental area,
- (c) CBM well drilling and completion,
- (d) CBM well testing,
- (e) CBM well fracturing and stimulation,
- (f) CBM reservoir simulation, and
- (g) CBM production.

## **Estimated Capital and O&M Costs**

Total finance of the project was US\$1.7 million, of which US\$1.3 million was provided by the UNDP as a grant and US\$0.4 million was by the Chinese government (50 million yuan). The project was managed by the China International Center for Economic and Technology Exchange (CICETC) of the Ministry of Economy and Trade and executed by the Northern China Bureau of Petroleum Geology.

## **Sources of Revenue**

Economic evaluation for gas utilization as town gas, fuel for small power plants, and feedstock for activated carbon and other chemical production were carried out showing promising economic benefits.

## **Proponents/ Sponsors of the Project**

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